Last time

- What is cognition?
- What are users good and bad at?
- Describe how cognition has been applied to interaction design
- Theories of cognition
  - Mental models, theory of action
  - Information processing
  - External cognition, distributed cognition
What goes on in the mind?

- perceiving
- thinking
- remembering
- learning
- planning a meal
- imagining a trip
- painting
- writing
- composing
- understanding others
- talking with others
- manipulating others
- making decisions
- solving problems
- daydreaming
Core cognitive aspects

- Attention
- Perception and recognition
- Memory
- Reading, speaking and listening
- Problem-solving, planning, reasoning and decision-making, learning
- Most relevant to interaction design are attention, perception and recognition, and memory
Design implications

- Don’t overload users’ memories with complicated procedures for carrying out tasks
- Design interfaces that promote recognition rather than recall
- Provide users with a variety of ways of encoding digital information to help them remember where they have stored them
  - e.g., categories, color, flagging, time stamping
Mental models

- Users develop an understanding of a system through learning and using it
- Knowledge is often described as a mental model
  - How to use the system (what to do next)
  - What to do with unfamiliar systems or unexpected situations (how the system works)
- People make inferences using mental models of how to carry out tasks
Mental models

- Craik (1943) described mental models as internal constructions of some aspect of the external world enabling predictions to be made.
- Involves unconscious and conscious processes, where images and analogies are activated.
- Deep versus shallow models (e.g. how to drive a car and how it works).
Everyday reasoning and mental models

(a) You arrive home on a cold winter’s night to a cold house. How do you get the house to warm up as quickly as possible? Set the thermostat to be at its highest or to the desired temperature?

(b) You arrive home starving hungry. You look in the fridge and find all that is left is an uncooked pizza. You have an electric oven. Do you warm it up to 375 degrees first and then put it in (as specified by the instructions) or turn the oven up higher to try to warm it up quicker?
Heating up a room or oven that is thermostat-controlled

- Many people have erroneous mental models (Kempton, 1996)
- Why?
  - General valve theory, where ‘more is more’ principle is generalised to different settings (e.g. gas pedal, gas cooker, tap, radio volume)
  - Thermostats based on model of on-off switch model
Heating up a room or oven that is thermostat-controlled

- Same is often true for understanding how interactive devices and computers work:
  - Poor, often incomplete, easily confusable, based on inappropriate analogies and superstition (Norman, 1983)
  - e.g. elevators and pedestrian crossings - lot of people hit the button at least twice
  - Why? Think it will make the lights change faster or ensure the elevator arrives!
Exercise: ATMs

Write down how an ATM works

- How much money are you allowed to take out?
- What denominations?
- If you went to another machine and tried the same what would happen?
- What information is on the strip on your card? How is this used?
- What happens if you enter the wrong number?
- Why are there pauses between the steps of a transaction? What happens if you try to type during them?
- Why does the card stay inside the machine?
- Do you count the money? Why?
How did you fare?

- Your mental model
  - How accurate?
  - How similar?
  - How shallow?

- Payne (1991) did a similar study and found that people frequently resort to analogies to explain how they work.

- People’s accounts greatly varied and were often ad hoc.
Norman’s (1986) Theory of action

- Proposes 7 stages of an activity
  - Establish a goal
  - Form an intention
  - Specify an action sequence
  - Execute an action
  - Perceive the system state
  - Interpret the state
  - Evaluate the system state with respect to the goals and intentions
How realistic?

- Human activity does not proceed in such an orderly and sequential manner.
- More usual for stages to be missed, repeated or out of order.
- Do not always have a clear goal in mind but react to the world.
- Theory is only approximation of what happens and is greatly simplified.
- Help designers think about how to help users monitor their actions.
The gulfs

- The ‘gulfs’ explicate the gaps that exist between the user and the interface
- The gulf of execution
  - the distance from the user to the physical system while the second one
- The gulf of evaluation
  - the distance from the physical system to the user
- Need to bridge the gulfs in order to reduce the cognitive effort required to perform a task
Information processing

- Conceptualizes human performance in metaphorical terms of information processing stages

![Diagram of information processing stages]

1. Input or stimuli
2. Encoding
3. Comparison
4. Response selection
5. Response execution
6. Output or response
Model Human processor (Card et al, 1983)

- Models the information processes of a user interacting with a computer
- Predicts which cognitive processes are involved when a user interacts with a computer
- Enables calculations to be made of how long a user will take to carry out a task
The human processor model
External cognition

- Concerned with explaining how we interact with external representations (e.g. maps, notes, diagrams)
- What are the cognitive benefits and what processes involved
- How they extend our cognition
- What computer-based representations can we develop to help even more?
Externalizing to reduce memory load

- Diaries, reminders, calendars, notes, shopping lists, to-do lists - written to remind us of what to do

- Post-its, piles, marked emails - where placed indicates priority of what to do

- External representations:
  - Remind us that we need to do something (e.g. to buy something for mother’s day)
  - Remind us of what to do (e.g. buy a card)
  - Remind us when to do something (e.g. send a card by a certain date)
Computational offloading

- When a tool is used in conjunction with an external representation to carry out a computation (e.g., pen and paper).

- Try doing the two sums below (a) in your head, (b) on a piece of paper and (c) with a calculator.

  - $234 \times 456 = ??$
  - $CCXXXIII \times CCCCXXXXVI = ???$

- Which is easiest and why? Both are identical sums.
Annotation and cognitive tracing

- Annotation involves modifying existing representations through making marks
  - e.g. crossing off, ticking, underlining

- Cognitive tracing involves externally manipulating items into different orders or structures
  - e.g. playing scrabble, playing cards
Design implication

- Provide external representations at the interface that reduce memory load and facilitate computational offloading.

  - e.g. Information visualizations have been designed to allow people to make sense and rapid decisions about masses of data.
Distributed cognition

- Concerned with the nature of cognitive phenomena across individuals, artifacts, and internal and external representations (Hutchins, 1995)
- Describes these in terms of propagation across representational state
- Information is transformed through different media (computers, displays, paper, heads)
How it differs from information processing

1. Traditional model
2. Distributed model
What’s involved

- The distributed problem-solving that takes place
- The role of verbal and non-verbal behavior
- The various coordinating mechanisms that are used (e.g., rules, procedures)
- The communication that takes place as the collaborative activity progresses
- How knowledge is shared and accessed
Key points

- Cognition involves several processes including attention, memory, perception and learning
- The way an interface is designed can greatly affect how well users can perceive, attend, learn and remember how to do their tasks
- Theoretical frameworks such as mental models and external cognition provide ways of understanding how and why people interact with products, which can lead to thinking about how to design better products
Chapter 4: Designing for collaboration and communication
Overview

- Conversational mechanisms
- Coordination mechanisms
- Awareness mechanisms
- Examples of technologies designed to extend how people talk and socialise
  - work together
  - play and learn together
Various mechanisms and ‘rules’ are followed when holding a conversation, e.g. mutual greetings

A: Hi there
B: Hi!
C: Hi
A: All right?
C: Good, how’s it going?
A: Fine, how are you?
C: OK
B: So-so. How’s life treating you?
Conversational rules

Sacks et al. (1978) work on conversation analysis describe three basic rules:
- Rule 1: the current speaker chooses the next speaker by asking an opinion, question, or request
- Rule 2: another person decides to start speaking
- Rule 3: the current speaker continues talking
Conversational rules

- Turn-taking used to coordinate conversation
  - A: Shall we meet at 8?
  - B: Um, can we meet a bit later?
  - A: Shall we meet at 8?
  - B: Wow, look at him?
  - A: Yes what a funny hairdo!
  - B: Um, can we meet a bit later?

- Back channeling to signal to continue and following
  - Uh-uh, umm, ahh
More conversational rules

- farewell rituals
  - Bye then, see you, yer bye, see you later....

- implicit and explicit cues
  - e.g., looking at watch, fidgeting with coat and bags
  - explicitly saying “Oh dear, must go, look at the time, I’m late...”
Breakdowns in conversation

- When someone says something that is misunderstood:
  - Speaker will repeat with emphasis:
    A: “this one?”
    B: “no, I meant that one!”

- Also use tokens:
  Eh? Quoi? Huh? What?
What happens in technology-mediated conversations?

- Do same conversational rules apply?
- Are there more breakdowns?
- How do people repair them for:
  - Phone?
  - Email?
  - IM?
  - Texting?
conversations differ for the same game of ZORKI?
Designing technologies to support conversations

- Much research focus has been on how to support conversations when people are ‘at a distance’ from each other.

- Many applications have been developed
  - e.g., email, videoconferencing, videophones, computer conferencing, instant messaging, chatrooms

- Do they mimic or move beyond existing ways of conversing?
VideoWindow system
(Bellcore, 1989)

- Shared space that allowed people 50 miles apart to carry on a conversation as if in same room drinking coffee together
- 3 x 8 ft ‘picture-window’ between two sites with video and audio
- People did interact via the window but strange things happened (Kraut, 1990)
Sketch of VideoWindow
Findings of how VideoWindow System was used

- Talked constantly about the system
- Spoke more to other people in the same room rather than in other room
- When tried to get closer to someone in other place had opposite effect - went out of range of camera and microphone
- No way of monitoring this
3D virtual worlds

- The rooftop garden in BowieWorld
- Users take part by “dressing up” as an avatar, including penguins and real people
- Once an avatar has entered a world they can explore it and chat to other avatars

Source: www.worlds.com/bowie
Massive 3D virtual worlds

  - Over 2 million users
- Habbo Hotel (2000)
  - Over 7 million players
  - Massively multiplayer online game

What kinds of conversation take place in these environments?
Hypermirror (Morikawa and Maesako, 1998)

allows people to feel as if they are in the same virtual place even though in physically different spaces

People in different places are superimposed on the same screen to make them appear as if in same space
2) Two in this room are invading the ‘virtual’ personal space of the other person by appearing to be physically on top of woman in white sweater.

3) Two in the room move apart to allow person in other space more ‘virtual’ personal space.
Everyone happy